

# Detecting the Intention to Conceal the Truth: An Event-Related Potential Study

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## Abstract

The present study investigated whether event-related potentials (ERPs) can reveal a hidden psychological process of concealing one's recognition of a certain fact. Eighteen participants were told to select one playing card from five. Then, the five cards and a joker were presented randomly one by one on a cathode ray tube screen. The participants were asked to respond selectively to the five cards and to the joker by pressing one of two buttons as quickly and accurately as possible. They were told that the experimenter attempted to detect the selected card on the basis of their physiological responses. In the concealing condition, participants were instructed to make an effort to leave the card that they selected undetected. In the control condition, participants showed the selected card to the experimenter beforehand and had no intention to conceal the card. The amplitude of the P300 component of the ERP has been assumed to reflect the subjective meaning or significance of the eliciting stimulus. The P300 amplitude was significantly larger for the selected card than for the not-selected cards only in the concealing condition. The reaction times did not differ between the conditions. The intention to conceal the selected card paradoxically made the card more significant, and this process was reflected in a larger P300. The results suggest that ERPs can reveal a hidden psychological process when coupled with an appropriate task.

**Key words:** *Lie detection, Concealed information tests, Intention, P300*

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## Introduction

Psychophysicologists have developed a method of lie detection known as the concealed information test (CIT), which assesses a suspect's recognition of a certain fact that only the perpetrator knows. Originally, the researchers recorded the activities of the autonomic nervous system, but event-related potentials (ERPs) as a measure of the central nervous system have been shown to be also effective for this purpose. Specifically, a cognitive ERP component, P300, which appears 300–600 ms after stimulus onset, has been used successfully in a number of ERP-based lie detection studies (Allen, Iacono, & Danielson, 1992; Farwell & Donchin, 1991; Rosenfeld, Cantwell, Nasman, Wojdac, Ivanov, & Mazzeri, 1988). The detection rate of concealed information has been reported to be slightly higher with ERP measures than with traditional autonomic measures (Ben-Shakhar & Elaad, 2003).

In a typical P300-based CIT, three types of items (relevant, irrelevant, and target) are presented randomly to examinees. Relevant items are the crime-related items

that only the perpetrator knows. Irrelevant items are the items that are similar to relevant items but unrelated to the crime. Target items are the items to which participants are asked to respond differently than to the relevant and irrelevant items. Innocent participants cannot differentiate the relevant and irrelevant items, but guilty participants can. Usually, four to six irrelevant items and one target item are combined with one relevant item (e.g., one relevant, four irrelevant, and one target). The purpose of including the target item in the CIT is to ensure that participants attend actively to the items. A poor performance of responding to the target is taken as a sign that the participants are not cooperative enough, probably because they have something to hide.

It is known that a large P300 is elicited by either an infrequent or a significant event (Johnson, 1988). The target item elicits a large P300 because it occurs infrequently and requires a selective response. On the other hand, the relevant item is more significant than the irrelevant items for the perpetrator who knows that the former item is related to the crime. Usually, the probabil-

ity of the relevant item is the same as the probability of each of the several irrelevant items. However, even when the probabilities of relevant and irrelevant items differ, the significance of the relevant item is shown to be the main determinant of P300 amplitude in the CIT (Kubo, Miyatani, & Nittono, 2007).

The purpose of the present study is to investigate whether ERPs can reveal a hidden psychological process such as the intention to conceal something. Previous P300-based CIT studies have investigated whether the P300 can reveal a participant's recognition of the relevant item (Allen et al., 1992; Farwell & Donchin, 1991; Rosenfeld, Rao, Soskins, & Miller, 2003). However, the perpetrator may not only have the item's recognition but also be motivated to conceal it. It remains unexamined whether the intention to conceal one's recognition of a certain fact can affect the P300 in the CIT. In this study, we compared the ERPs in the CIT with and without intention to conceal one's recognition of the relevant item.

## **Methods**

### *Participants*

Eighteen students participated in the study (9 females and 9 males, 20–27 years old,  $M = 21.6$  years old). All of them were right-handed and had normal or corrected-to-normal sight, according to the self-report. They gave written informed consent.

### *Stimuli and Procedure*

Participants were told to select one playing card from five. Hereafter, the selected card is called the relevant card and the not-selected cards are called irrelevant cards. Then, the five cards and a joker (target) were presented one by one on a cathode ray tube screen for 300 ms with an interstimulus interval of 1,500–1,900 ms ( $M = 1,700$  ms). The participants were asked to respond selectively to the five cards and to the joker by pressing one of two buttons as quickly and accurately as possible. They were told that the relevant card would elicit a larger brain electrical response compared with the irrelevant cards and that the experimenter attempted to detect the selected card according to this information. In the concealing condition, participants were asked to make an effort to leave the relevant card undetected by suppressing the brain response to it. In the control condition, participants showed the selected card to the experimenter beforehand and had no intention to conceal the card. For each condi-

tion, participants performed 180 trials. Relevant and target cards were presented in 30 trials each ( $p = .17$  each), and irrelevant cards were presented in 120 trials (30 trials each for four irrelevant cards,  $p = .66$ ).

### *Physiological Recording*

An electroencephalogram (EEG) was recorded from 38 scalp sites using an elastic cap (EASYCAP, Munich, Germany) with Ag/AgCl electrodes. A high-pass filter of 0.016 Hz (a time constant of 10 s) and a low-pass filter of 60 Hz were used at recording. Horizontal and vertical electrooculograms (EOGs) were recorded from the outer canthi and from above and below the left eye. The sampling rate was 500 Hz. Electrode impedance did not exceed 5 k $\Omega$ .

### *Data Reduction*

The EEG data were re-referenced to the nose tip. A digital bandpass filter of 0.05–30 Hz was applied and ocular artifacts were corrected. ERP waveforms were calculated separately for each participant, stimulus type (relevant, irrelevant, and target), and condition (concealing and control). The period between 200 ms before and 1,000 ms after the stimulus onset was averaged. P300 amplitudes for the relevant and irrelevant cards were scored as the mean amplitudes between 450 and 650 ms at the most dominant site, Pz. P300 amplitude for the target card was scored as the peak amplitude of the most positive deflection in a latency range of 300–600 ms at Pz.

### *Statistical Analysis*

Mean reaction time and ERP amplitude data were submitted to repeated measures analyses of variance (ANOVAs). When the degree of freedom in the numerator was more than one, Greenhouse-Geisser  $\epsilon$  correction was applied to control Type I error. Post hoc comparisons were made by paired  $t$  tests with the Bonferroni correction. The significance level was set at .05 for all analyses.

## **Results**

Table 1 shows the mean reaction times in the concealing and control conditions. The data were submitted to an ANOVA with factors of stimulus type (target vs. relevant vs. irrelevant) and condition (concealing vs. control). The main effect of the condition was not sig-

**Table 1.** Means  $\pm$  standard deviations of mean reaction times (ms)

	Concealing	Control
Target	471 $\pm$ 51	465 $\pm$ 46
Relevant	344 $\pm$ 48	337 $\pm$ 52
Irrelevant	338 $\pm$ 49	335 $\pm$ 43

nificant,  $F(1, 17) = 1.10, p = .30$ , but the main effect of the stimulus type was significant,  $F(2, 34) = 330.81, p < .001, \epsilon = .65$ . Post hoc comparisons showed that the reaction time was significantly longer for the target card than for the relevant and irrelevant cards, the latter of which did not differ significantly from each other. The interaction was not significant,  $F < 1$ .

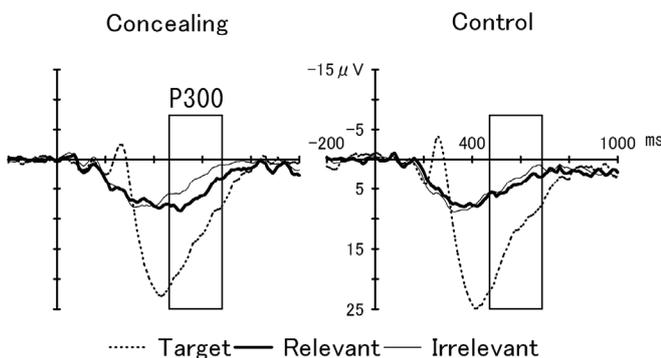
Figure 1 shows grand mean ERP waveforms in the concealing and control conditions. The target card elicited a large P300 with a peak around 400 ms after stimulus onset in both conditions. Although their amplitudes were much smaller, the relevant and irrelevant cards also elicited a P300. The after-peak slope of the P300 appears to be larger for the relevant than for the irrelevant cards, and this tendency is prominent in the concealing condition.

Figure 2 shows the P300 amplitude for each stimulus type in both conditions. The data were submitted to an ANOVA with factors of stimulus type (relevant vs. irrelevant) and condition (concealing vs. control). The main effect of the condition was not significant,  $F < 1$ ,

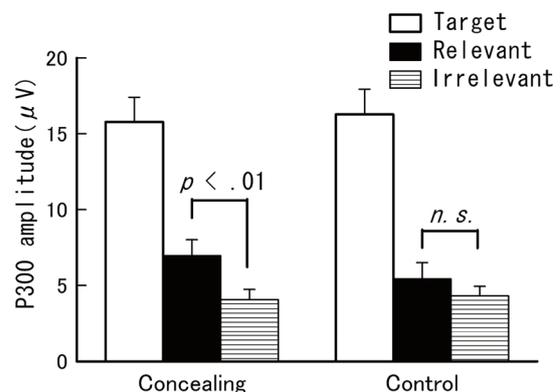
but the main effect of the stimulus type was significant,  $F(1, 17) = 8.67, p = .009$ . The P300 amplitude was significantly larger for the relevant card than for the irrelevant cards. Although the interaction of stimulus type and condition was not significant,  $F(1, 17) = 2.30, p = .15$ , the effect size of the difference between the relevant and irrelevant cards was larger in the concealing condition ( $d = 0.77$ ) than in the control condition ( $d = 0.31$ ). When analyzed separately, P300 amplitude was significantly larger for the relevant than for the irrelevant cards only in the concealing condition. The P300 amplitude and latency for the target card did not differ between the conditions.

### Discussion

The amplitude of the P300 has been assumed to reflect the subjective meaning or significance of the eliciting stimulus. When participants had no intention to conceal the card that they selected, that card did not elicit a significantly larger P300 than the other, not-selected cards. In contrast, when participants were told to conceal the selected card, the amplitude difference between the selected and not-selected cards increased. The intention to conceal the selected card paradoxically made the card more significant, and this process was reflected in a larger P300. The results suggest that ERPs can reveal a hidden psychological process when they are coupled with an appropriate task.



**Figure 1.** Grand mean ERP waveforms elicited by the target, relevant, and irrelevant cards in the concealing and control conditions.



**Figure 2.** P300 amplitudes in the concealing conditions. The amplitude for the target card was scored as a peak amplitude, and the amplitudes for the relevant and irrelevant cards were scored as a mean amplitude of 450–650 ms.

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